CLAIMS:

1. A lithographic projection apparatus comprising:

a radiation system to provide a projection beam of radiation;

patterning structure to pattern the projection beam according to a desired pattern;

a substrate table to hold a substrate;

a projection system to image the patterned beam onto a target portion of the substrate,

a displacement measuring interferometer having an operating wavelength λ_1 for measuring at least one of the position of said substrate table and the position of a table which is a part of said patterning structure;

a purge gas source to supply purge gas to a space, to displace therefrom ambient air, said space accommodating at least one of at least a part of said substrate table and at least a part of said table which is a part of said patterning structure, wherein said purge gas is substantially non-absorbent of said projection beam of radiation and has a refractive index at a wavelength λ_1 which is substantially the same as that of air when measured at equal wavelength, temperature and pressure.

2. An apparatus according to claim 1 wherein the purge gas comprises two or more components selected from N_2, He, Ar, Kr, Ne and Xe.

3. An apparatus according to claim 2 wherein said purge gas comprises at least 95% by volume N_2 and at least 1% by volume He.

4. An apparatus according to claim 2 wherein said purge gas comprises at least 95% by volume Ar and at least 1% by volume Xe.

5. An apparatus according to claim 2 wherein said purge gas comprises at least 90% by volume Ar and at least 5% by volume Kr.

6. An apparatus according to claim 2, wherein said purge gas comprises at least 95% by volume N_2 and at least 1% by volume Ne.

7. An apparatus according to claim 2, wherein said purge gas comprises at least 50% by volume N_2 and at least 35% by volume Ar.

8. An apparatus according to claim 2 wherein said purge gas comprises at least 94% by volume N_2, at least 0.5% by volume He and at least 0.5% by volume Xe.

9. An apparatus according to claim 1, which further comprises a second harmonic interferometer having operating wavelengths λ_2 and λ_3 to adjust measurements of said displacement measuring interferometer to substantially eliminate effects of variation in pressure and temperature, and

wherein said purge gas comprises at least three different components, each component having refractivities at the wavelengths λ_2 and λ_3 such that the following equations are substantially fulfilled:

$$\sum_{j}^{k} F_j \alpha_{j1} = \alpha_{a1} \tag{1}$$

$$\sum_{j}^{k} F_j (\alpha_{j3} - \alpha_{j2}) = \alpha_{a3} - \alpha_{a2} \tag{2}$$

wherein F_j is the fraction by volume of component j in the purge gas, which purge gas contains a total of k components, α_{j1} is the refractivity of component j at a wavelength λ_1, α_{j2} is the refractivity of component j at a wavelength λ_2, α_{j3} is the refractivity of component j at a wavelength λ_3, α_{a1} is the refractivity of air at a wavelength λ_1, α_{a2} is the refractivity of air at a wavelength λ_2 and α_{a3} is the refractivity of air at a wavelength λ_3; and wherein:

$$\sum_{j}^{k} F_j = 1. \tag{3}$$

10. An apparatus according to claim 9, wherein said purge gas comprises at least three different components selected from N_2, He, Ar, Kr, Ne and Xe.

11. An apparatus according to claim 10, wherein said purge gas comprises (i) N_2 and/or Ar in an amount of from 50-90% by volume, (ii) Xe and/or Kr in an amount of from 0.5 to 40% by volume and (iii) He and/or Ne in an amount of from 2 to 20% by volume.

12. A lithographic projection apparatus comprising:

a radiation system to provide a projection beam of radiation;

patterning structure to pattern the projection beam according to a desired pattern;

a substrate table to hold a substrate;

a projection system to image the patterned beam onto a target portion of the substrate;

a displacement measuring interferometer having an operating wavelength λ_1 to measure at least one of a position of said substrate table and a position of a table which is a part of said patterning structure;

a second harmonic interferometer having operating wavelengths λ_2 and λ_3 to adjust measurements of the displacement measuring interferometer to substantially eliminate the effects of variation in pressure and temperature;

a purge gas source to supply purge gas to a space, to displace therefrom ambient air, said space accommodating at least one of at least a part of said substrate table and at least a part of said table which is a part of said patterning structure, wherein said purge gas is substantially non-absorbent of said projection beam of radiation and comprises at least two components, each component having refractivities at the wavelengths λ_1, λ_2 and λ_3 such that the following equation is substantially fulfilled:

$$\frac{\alpha_{m1}}{(\alpha_{m3} - \alpha_{m2})} = K_a \qquad (4)$$

wherein α_{m1} is the refractivity of the purge gas at a wavelength λ_1, α_{m2} is the refractivity of the purge gas at a wavelength λ_2, α_{m3} is the refractivity of the purge gas at a wavelength λ_3 and

$$K_a = \frac{\alpha_{a1}}{(\alpha_{a3} - \alpha_{a2})} \qquad (5)$$

wherein α_{a1} is the refractivity of air at a wavelength λ_1, α_{a2} is the refractivity of air at a wavelength λ_2 and α_{a3} is the refractivity of air at a wavelength λ_3.

13. An apparatus according to claim 12, wherein said purge gas comprises at least two gases selected from N_2, He, Ar, Kr, Ne and Xe.

14. An apparatus according to claim 13, wherein said purge gas comprises (i) N_2, He, Ar and/or Ne in an amount of from 65 to 99.5% by volume and (ii) Kr and/or Xe in an amount of from 0.5 to 35% by volume.

15. A lithographic projection apparatus comprising:

a radiation system to provide a projection beam of radiation;

patterning structure to pattern the projection beam according to a desired pattern;

a substrate table to hold a substrate;

a projection system to image the patterned beam onto a target portion of the substrate;

a purge gas source to supply purge gas to a space, to displace therefrom ambient air, said space accommodating at least one of at least a part of said substrate table and at least a part of said table which is a part of said patterning structure, wherein said purge gas is substantially non-absorbent of said projection beam of radiation;

an displacement measuring interferometer having an operating wavelength λ_1 for measuring at least one of the position of said substrate table and the position of said table which is a part of said patterning structure; and

a second harmonic interferometer having operating wavelengths λ_2 and λ_3 to adjust measurements of the displacement measuring interferometer (DI) according to the following equation:

$$L = (DI) - K(SHI) \tag{9}$$

wherein L is the adjusted displacement measuring interferometer measurement, SHI is the measurement of the second harmonic interferometer and K is a coefficient, the value of which is optimized such that effects of variation in pressure, temperature and purge gas composition are partially eliminated from the adjusted measurement L.

16. An apparatus according to claim 15, wherein said purge gas has a refractive index at a wavelength λ_1 which is substantially the same as that of air when measured at the same wavelength, temperature and pressure.

17. An apparatus according to claim 15, wherein K is given by the equation:

$$K = \frac{(\alpha_{c3} - \alpha_{c2})(\alpha_{c1})\left(\frac{\sigma_\rho}{\rho_0}\right)^2 + (\alpha_{m1} - \alpha_{a1})(\alpha_{m3} - \alpha_{m2} - \alpha_{a3} + \alpha_{a2})\sigma_C^2}{(\alpha_{c3} - \alpha_{c2})^2\left(\frac{\sigma_\rho}{\rho_0}\right)^2 + (\alpha_{m3} - \alpha_{m2} - \alpha_{a3} + \alpha_{a2})^2\sigma_C^2} \qquad (22)$$

wherein α_{mx} and α_{ax} represent the refractivity of the purge gas or air respectively at a wavelength λ_x and α_{cx} represents the refractivity of air contaminated by a relative amount c of the purge gas at a wavelength λ_x, ρ represents quotient pressure divided by absolute temperature, σ_ρ is the standard deviation of ρ and σ_c is the standard deviation of c.

18. An apparatus according to claim 15, wherein the purge gas comprises at least 95% by volume He.

19. An apparatus according to claim 15, wherein the purge gas comprises from 94 to 96 % by volume N_2 and from 4 to 6% by volume He.

20. An apparatus according to claim 1 wherein λ_1 is about 633nm, λ_2 is about 532nm and λ_3 is about 266nm.

21. An apparatus according to claim 1, wherein said purge gas supply comprises a gas flow regulator to control a rate of flow of purge gas to said space and a pump to remove purge gas from said space.

22. An apparatus according to claim 21 wherein said flow regulator comprises a flow restrictor.

23. An apparatus according to claim 21 wherein said flow regulator comprises a blower.

24. An apparatus according to claim 1 wherein said radiation of said projection beam has a wavelength less than about 180nm.

25. An apparatus according to claim 24 wherein said radiation of said projection beam has a wavelength selected from the group comprising about 157nm and about 180nm.

26. A device manufacturing method comprising:

projecting a patterned beam of radiation onto a target area of a layer of radiation-sensitive material on a substrate;

determining the position of a table using a displacement measuring interferometer having an operating wavelength λ_1, said table comprising at least one of a substrate holder and a patterning structure;

providing purge gas to a space accommodating at least a part of said table to displace therefrom ambient air, wherein said purge gas is substantially non-absorbent of said patterned beam of radiation and has a refractive index at a wavelength λ_1 which is substantially the same as that of air when measured at the same wavelength, temperature and pressure.

27. A method according to claim 26, which further comprises adjusting the measurement of said displacement measuring interferometer to substantially eliminate effects of variation in pressure and temperature using a second harmonic interferometer having operating wavelengths λ_2 and λ_3; and

wherein said purge gas comprises at least three different components, each component having refractivities at the wavelengths λ_2 and λ_3 such that the following equations are substantially fulfilled:

$$\sum_{j}^{k} F_j \alpha_{j1} = \alpha_{a1} \qquad (1)$$

$$\sum_{j}^{k} F_j (\alpha_{j3} - \alpha_{j2}) = \alpha_{a3} - \alpha_{a2} \qquad (2)$$

wherein F_j is a fraction by volume of component j in the purge gas, which purge gas contains a total of k components, α_{j1} is a refractivity of component j at a wavelength λ_1, α_{j2} is a refractivity of component j at a wavelength λ_2, α_{j3} is a refractivity of component j at a wavelength λ_3, α_{a1} is a refractivity of air at a wavelength λ_1, α_{a2} is a refractivity of air at a wavelength λ_2 and α_{a3} is a refractivity of air at a wavelength λ_3, and wherein:

$$\sum_{j}^{k} F_j = 1. \qquad (3)$$

28. A device manufacturing method comprising:

projecting the patterned beam of radiation onto a target area of the layer of radiation-sensitive material,

determining a position of a table using a displacement measuring interferometer having an operating wavelength λ_1, said table comprising at least one of a substrate holder and a patterning structure;

adjusting a measurement of said displacement measuring interferometer to substantially eliminate effects of variation in pressure and temperature using a second harmonic interferometer having operating wavelengths λ_2 and λ_3;

providing purge gas to a space accommodating at least a part of said table to displace therefrom ambient air, wherein said purge gas is substantially non-absorbent of said patterned beam of radiation and comprises at least two components, each component having refractivities at the wavelengths λ_1, λ_2 and λ_3 such that the following equation is substantially fulfilled:

$$\frac{\alpha_{m1}}{(\alpha_{m3} - \alpha_{m2})} = K_a \qquad (4)$$

wherein α_{m1} is a refractivity of the purge gas at a wavelength λ_1, α_{m2} is a refractivity of the purge gas at a wavelength λ_2, α_{m3} is a refractivity of the purge gas at a wavelength λ_3 and

$$K_a = \frac{\alpha_{a1}}{(\alpha_{a3} - \alpha_{a2})} \qquad (5)$$

wherein α_{a1} is a refractivity index of air at a wavelength λ_1, α_{a2} is a refractivity of air at a wavelength λ_2 and α_{a3} is a refractivity of air at a wavelength λ_3.

29. A device manufacturing method comprising:

projecting a patterned beam of radiation onto a target area of a layer of radiation-sensitive material on a substrate,

providing purge gas to a space accommodating at least a part of a table to displace therefrom ambient air, said table comprising at least one of a substrate holder and a patterning structure, wherein said purge gas is substantially non-absorbent of said projection beam of radiation;

determining a position of said table using a displacement measuring interferometer having an operating wavelength λ_1; and

adjusting the measurement of said displacement measuring interferometer (DI) using a second harmonic interferometer having operating wavelengths λ_2 and λ_3 according to the following equation:

$$L = (DI) - K(SHI) \qquad (9)$$

wherein L is an adjusted displacement measuring interferometer measurement, SHI is a measurement of the second harmonic interferometer and K is a coefficient, a value of which is optimized such that the effects of variation in pressure, temperature and purge gas composition are partially eliminated from the adjusted value L.

30. A device manufactured according to the method of claim 26.

31. A purge gas as defined in claim 3.